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HOW CAN THE NORTH POLAR REGION BE CROSSED?

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Geographical exploration has now made rapid progress, and most of the Earth's surface is already fairly well known. There are, however, two regions of our globe which have hitherto obstinately resisted all explorers: these are the regions around the poles. As science has advanced, and the world has become more and more known, problems have arisen which can only be solved by observations in these regions; it is now hardly possible to study physical geography, geology, meteorology, and many other branches of science, without being stopped by important questions which can only be answered in the Arctic and Antarctic regions, and in regard to which we can at present only offer highly uncertain hypotheses. It is therefore natural that the interest of the scientific world should more and more be turned towards the exploration of these regions, and I feel certain that all scientific geographers agree that they ought to be explored without delay; but as to the way in which this ought to be done, I am afraid there is much difference of opinion.

Each polar region is interesting in its own way, and we are not at all entitled to say that the exploration of the one would be of more importance than that of the other. It is certainly the North Pole which has hitherto attracted the greatest amount of attention, but the chief reason for this is probably the circumstance that it is situated in our own hemisphere. There is a striking difference between the two poles. The South Pole is surrounded, at a considerable distance, by a great ocean, while it is probably situated in a large continent covered by an immense ice-sheet, thicker and much more extensive than that of Greenland. The exploration of this ice-sheet would be a scientific event of the highest importance, and no one can doubt that one day it will be

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carried out. The Arctic regions, on the other hand, are on all sides surrounded by extensive land masses, while the neighbourhood of the Pole itself is covered by water. For this reason sailors have entertained the most fantastic ideas about an open Polar Sea, by which a short passage might even be found to the riches of China and India. They have tried to reach the Pole from all sides, but everywhere their hopes have been wrecked on the floe-ice, and the Polar Sea has been the grave of many a sailor's dreams of fame and wealth. I will here briefly mention the routes by which the principal attempts have been made.

Smith Sound was for some time thought to be the "high road" to the Pole, as some American explorers by this route had somewhat rashly professed to have seen the open Polar Sea stretching away to the north. All expeditions were, however, effectually stopped by floe-ice, carried down by a current from the north. Travelling over this ice was uncertain and difficult work, as may easily be concluded from the experiences of Markham, during his sledge journey towards the north on the Nares expedition. The most northerly points yet reached are, however, in this region, Markham having penetrated to lat. 83° 20′ N. (1876), and Lockwood, of the Greely expedition, to lat. 83° 24′ N. (1882).

Along the east coast of Greenland, attempts toward the Pole have been made, especially by the so-called second German North Pole expedition (1869–70). They were soon stopped by floe-ice swept southward by the polar current, and did not reach very high latitudes (c. 77 N.).

North of Spitzbergen, Sir Edward Parry made a most energetic attempt in 1827. When his vessel was stopped he left it, and tried to advance over the floe-ice, dragging boats and sledges with him. He reached lat. 82° 45′ N., where he was, however, obliged to return, as the ice was drifting so rapidly southward, that he could make no headway against it. In spite of the steamships of our time, nobody has reached Parry's latitude in this direction; but no serious attempt has been made since then.

In the direction of Franz Josef Land, attempts have also been made, but they have met with the same obstacle as elsewhere, viz. the polar ice. The ice was not here, however, carried southward, and this is a difference from what has been the case in the regions previously mentioned, which ought to be noticed. The Austrian *Tegetthoff* expedition was nipped off the coast of Novaya Zemlya, but was during one year and a half drifted in the ice north-east, north, and north-westward, till at last it was stopped by Franz Josef Land, which was thus discovered.

On the side of the Bering Strait only a few attempts have been made. The first was Cook's expedition in 1776, and the last that of the *Jeannette*

in 1879–81. Here, also, the same difficulty, the floe-ice, was met with, and in lower latitudes than anywhere else. The *Jeannette* was caught in the ice near latitude 71° N., and south-east of Wrangel Island. Here, we have, however, again a peculiarity as to the direction in which the ice is drifted; she was not carried southward but north-westward and nearer to the Pole. In this respect the *Tegetthoff* expedition, and that of the *Jeannette* differ from all others.

Why, then, have all previous attempts failed? The reason is simple enough. The expeditions were everywhere, at a greater or less distance from the Pole, stopped by the drifting floe-ice which formed immense impenetrable masses, and in most cases was carried down against the ships by currents from the north. It was impossible to penetrate the ice, and to walk over it was almost equally impossible, since it is moved by constant currents from the north; there was no choice left but to return. If we could only discover a land stretching to the Pole, the chances would be favourable enough. The difficulties of reaching it would not then be much greater than that of crossing Greenland. But we know of no country which is likely to have such an extension to the North. Greenland seems to end not very far north of the latitude already reached, and Franz Josef Land is probably only a group of islands.

Many people think that the North Pole can be reached by balloons or balloon ships, and that it will be so reached one day. I do not deny the possibility of this; on the contrary, I regard it as very probable. But the only way at present would be to entrust oneself wholly to the wind, and this is an uncertain way so long as we have no knowledge of the wind-currents of these regions. To go in a submarine boat under the ice would be rather risky so long as submarine navigation is as little developed as it is at present.

But is there no other way to reach the North Pole? I believe that if we take careful notice of the forces which Nature herself places at our disposal, and endeavour to work with them, and not against them, we shall find, if not the shortest, at all events the most certain route. We have already seen that most polar expeditions have been stopped by irresistible currents from the unknown north, carrying immense masses of thick floe-ice. From this fact we seem entitled to draw a very simple conclusion, namely, that if currents run from these regions, currents must also somewhere run into them, and that if expeditions have been carried by the ice southward from the unknown regions, others may be floated northward into those regions if they can only strike the currents on the right side. Thus, then, we have the way already indicated; the problem is to find the right place.

If we consider the experience of whalers and sealers who have sailed for a long series of years in the Arctic seas on both sides of the Pole, one singular circumstance must strike us at once, namely, that ships

caught in the ice on this side of the pole near the Greenland Sea are carried southward, and that the crews run, as a rule, no great risk. Not so on the other side of the Pole north of Bering Strait; ships caught in the ice there drift northward and often disappear, some with few and others with many men on board; most of them probably are destroyed in high unknown latitudes. These facts must lead the thoughtful observer to the conclusion that there are differences in the sea currents which may be utilised in favour of a polar expedition. Let us, therefore, examine the question more closely.

The most important polar current is, without doubt, that which runs southward along the east coast of Greenland. This has a considerable speed, and carries an immense quantity of water out from the polar basin. It fills the whole opening between Greenland and Spitzbergen, with the exception of a narrow belt along the coast of the latter, and it runs over the deepest known bottom in the Arctic regions; there are ascertained depths of 2600 fathoms. The depth of the actual current itself cannot, however, be so much; I do not think that we are entitled to assume that there is any current of importance deeper than 300 fathoms; and in order to be within the mark, let us say only 200 fathoms. It might be expected that under this polar current another current was running northward. From what we know of the water, we seem, however, to be fully entitled to say that such cannot be the case. On the contrary, water at a much greater depth probably comes from the unknown north. The breadth of the polar current on the surface is 250 nautical miles, and at the depth mentioned it seems to be about 170 nautical miles. To calculate the average speed of the current is very difficult; it runs probably more rapidly at the surface than in its deeper parts, and, on the other hand, the speed is nowhere constant during the whole year. Sometimes, especially in the summer months, it is very rapid, but at other times it seems to have a much slower course. Taking everything into consideration, I do not think we are entitled to estimate the average speed of the whole current for the year at more than two nautical miles a day. By this calculation we arrive at the conclusion that the polar current between Greenland and Spitzbergen *carries southward between* 80 *and* 120 *cubic miles of water every twenty-four hours.*

Whence is all this water derived? It cannot originate at the pole itself; the place of the water that flows out from the polar basin must be supplied by water running in. It is also evident that the influence of a current so considerable as this cannot be limited to a small area; it must affect the polar basin like an immense pump, sucking the water even from the shores of Siberia and Bering Strait. This is the more certain, as the polar basin is found to be unusually shallow wherever it has been sounded. There are only a few currents known which run into the polar basin. A small branch of the Gulf Stream is known to

run northward along the west coast of Spitzbergen. This current is, however, too insignificant to be of much value in this connection; to some extent it certainly also rounds the north coast of Spitzbergen, and returns southward again towards its eastern coast. The main body of the Norwegian Gulf Stream passes eastward to the north of Norway, and enters the polar basin north of Novaya Zemlya. This current is considerable; our knowledge of it is, however, not sufficient to enable us to form any certain idea about the quantity of water which it carries along; but according to the calculation of Prof. H. Mohn, in his important memoir on the Northern Ocean,* and according to information from the sealers, I think we may assume that it carries at least 60 or 70 cubic miles of water every twenty-four hours into the polar basin. A third current running into the Polar Sea is that which runs northward through Bering Strait. This cannot be of great importance, as the strait is so narrow and shallow, but from the latest descriptions of the current we are perhaps entitled to assume that at least 10 or 14 cubic miles of water are here running northward daily.

The currents certainly furnish the most important supplies of water to the polar current along the east coast of Greenland. Another addition comes from the American, and especially from the Siberian rivers that run into the polar sea. The drainage area of all these rivers is very considerable, embracing nearly the whole of northern Asia, or Siberia, besides the principal part of Alaska and British North America. The rain and snow of this region are not, however, very considerable, and the whole quantity of moisture falling over Siberia I have calculated to be no more than about 626 cubic miles in one year if the Russian meteorological data on Siberia are correct. On account of evaporation we cannot assume that more than a certain part of this water reaches the Polar Sea; perhaps not more than one cubic mile daily during the year. This is not much, compared with the size of the ocean currents, but this addition is of special importance, as it consists of fresh and comparatively warm water which principally runs out into the basin during the summer, and which for a very long time keeps at the surface of the sea on account of its lightness, and thus produces surface currents running northward from the Siberian coast. This is also the reason why there is so much open water along this coast every summer. To this stream of fresh water the evaporation from the melting of ice in the Polar Sea contributes very little. The moisture of the air over the area draining into the Polar Sea must consequently originate mainly in the Atlantic and Pacific Oceans. This constant addition of fresh water must evidently be the principal reason why the water of the polar current between Greenland and Spitzbergen contains somewhat

* Prof. H. Mohn, 'The North Ocean; its Depths, Temperature, and Circulation. The Norwegian North Atlantic Expedition, 1876–78.' Christiania 1887.

less salt, even at considerable depths, than the water of the North Atlantic seas.

We thus see that the polar basin is daily receiving a large inflow of water. As little evaporation takes place from its ice-covered surface, there must necessarily be a corresponding outflow, and the most natural outlet is the broad and deep opening between Spitzbergen and Greenland. According to what has already been said the water running out here seems very nearly to correspond in quantity to the inflow mentioned.

Currents also run southward through Smith Sound, Jones Sound, and Lancaster Sound, in the Arctic Archipelago of North America, but as these sounds are very narrow and shallow, the body of water which their currents carry off is of little importance in this respect. The current running southward between Spitzbergen and Franz Josef Land is also insignificant when compared to the east Greenland current. By considering the contributions of water already referred to which this last current probably receives, it may be possible to form some idea of the approximate course of this current through the unknown regions. The waters of the North American rivers form, very likely, a portion of the currents through the Arctic Archipelago of North America; a small part of the current through Bering Strait, perhaps, runs also in this direction. We have left then, for the formation of the east Greenland polar current, the Novaya Zemlya current, the Siberian rivers, a part of the current through Bering Strait, and the moisture falling over the polar basin.

It seems quite natural that these sources should converge, and to some extent unite to form the Greenland current. We must expect, therefore, to find the main body of the current which is formed in this way, lying somewhere to the north of the middle of that extended area from which it receives its converging sources, and this place must consequently be somewhere in the neighbourhood of the New Siberian Islands. Here we also have the mouth of the Lena River, which carries a considerable body of comparatively warm water northward into the Polar Sea. From this region the current must naturally run in a northerly direction by the shortest route to the outlet between Spitzbergen and Greenland, and this must be to the north of Franz Josef Land and near or across the North Pole. But the direction of the current may perhaps, to some extent, be disturbed by the winds. Unfortunately we do not know much of these in the Arctic regions; from the little we know it would appear, however, that the winds should be favourable for such a current, and that their average direction during the year is very nearly the same as that which we have assumed for the latter. This we can also conclude from the observations made during the drift of the *Jeannette*.

I have tried to convince you that, from what we know about the

ocean currents and the winds along the "threshold of the unknown regions," we are entitled, in fact are obliged, to assume that these regions are traversed by an ocean current. But is there no direct evidence of the existence of such a current? I think there is.

The American *Jeannette*, under the command of De Long, was on September 6th, 1879, caught in the ice to the east of Herald Island (north of Bering Strait at about lat. 71·30° N., long. 175° W.). This is the only case in which we know exactly the drift of a ship caught in the ice north of Bering Strait. Like all other ships caught there, the *Jeannette* drifted towards the north and north-west, but her course was at first very irregular, and to a great extent dependent on the varying winds. Her main drift, however, had a decidedly north-westerly direction; this course grew more and more direct the more the ship advanced westward, and during the last half year of her drifting she kept a pretty straight course, advancing north-westward with an average speed of no less than two miles daily, until she was crushed in the ice and sank on June 13, 1881, north of the New Siberian Islands (at about lat. 77° 15′ N., long. 155° E.). This drift of the *Jeannette* shows that a current must be running north-westward from the sea north of Bering Strait. This current does not seem to have been very strong during the first part of her drift, but as she approached the region to the north of the New Siberian Islands the current seemed to get a stronger and stronger hold of her, and the last week before she sank she often drifted along with a speed of more than eight miles daily. This was just near the region where I have already supposed the Greenland current to originate.

More remarkable, however, in this respect than the drift of the *Jeannette* itself, is the fact that a number of objects belonging to her or her crew were found on an ice-floe near Julianehaab, on the south-west coast of Greenland, just three years after she had sunk (June 18th, 1884). These objects, fifty-eight in number, were found by some Eskimo, and were afterwards collected by the director of the colony of Julianehaab, Mr. Lytzen, who has described them in a paper in the *Geografisk Tidskrift* (vol. viii., 1885–86, pp. 49–51), which is issued by the Danish Geographical Society in Copenhagen. Among these objects the following may be mentioned here:—1. A list of provisions with the signature of De Long, the leader of the *Jeannette* expedition, in his own handwriting; 2. A written list of the boats of the *Jeannette*; 3. A pair of trousers made of oiled linen, marked "Louis Noros," which is the name of one of the men saved from the *Jeannette*.

There seems to be some doubt as to the genuineness of these relics, and a well-known American traveller has even maintained that if the articles were found, it would seem more reasonable to trace them to the *Proteus*, which was wrecked in Smith Sound, about 1000 miles north of Julianehaab (in July, 1883). But how a list of provisions with De

Long's signature, a list of the boats of the *Jeannette*, a pair of trousers marked Louis Noros, &c., were brought on board the *Proteus* he does unfortunately not inform us. If the articles had still existed it would have been very easy to identify them, but unfortunately they are now lost. Mr. Lytzen sent them to a friend in Copenhagen, who had them for some time, and sent them to the International Exhibition at Amsterdam. After the close of the latter they were returned to the friend in a wooden case, and were placed in the cockloft in his house. A few years ago this man died, and his wife, not knowing what the articles were, allowed them to be destroyed, and I came just two months too late to save them. But I cannot see why these relics should not be genuine. What could the natives of Greenland know about the *Jeannette* and her sad fate? Or can it be supposed that Mr. Lytzen, a respectable official of Greenland, should have invented a story like this, and given a minute description of articles never found? Nobody who has read his description can easily believe such a thing, and that there should be any mistake or deceit is certainly much more improbable than the drift of a floe from Siberia to Greenland, which is certainly not at all improbable seeing that a great many other objects known must have drifted, and constantly do drift, the same way. The above-mentioned facts seem to speak for themselves, and need no further testimony. We have consequently to deal with the fact that an ice-floe, with objects from the *Jeannette* lying on it, was found near Julianehaab. These objects must have been left on the floe either near the place where the *Jeannette* sank or somewhere on the route of her crew towards the Lena delta. It is quite impossible that this floe could have come to the south-west coast of Greenland through Smith Sound, Jones Sound, or Lancaster Sound, as the currents through these sounds run southward along the west side of Baffin's Bay and Davis Strait, along the east coasts of Baffin Land and Labrador towards Newfoundland. No ice or objects coming that way reach the south-west coast of Greenland, along which a current runs northward, coming from the east coast (of Greenland) and round Cape Farewell, carrying along all the floe-ice and foreign objects which are found on the southern part of the west coast. There can consequently be no doubt that the floe which carried these relics from the *Jeannette* was borne along by the East Greenland current.

The question therefore arises: by what route did it travel all the way from the New Siberian Islands to the east coast of Greenland? The shortest and most natural route would, of course, be across the region to the north of Franz Josef Land, i.e. across the region round the pole; nay, we are obliged to assume this route as the only possible one. There is no probability that the floe should have been able to travel against the before-mentioned branch of the Gulf Stream, running eastward into the polar basin through the sound between Novaya Zemlya and Franz Josef Land, and that it should thus have passed westward to the south

of the latter, to the south of Spitzbergen and across the branch of the Gulf Stream, running northward along its western coast. Even if it were really possible that a floe could overcome all the difficulties of such a complicated route without being melted by the warm Gulf Stream, being broken up in the open sea, &c., it could not easily have travelled so far during so short a time as three years, seeing that the Austrians on board the *Tegetthoff* required one year and a half to be transported from Novaya Zemlya to Franz Josef Land.

These relics from the *Jeannette* thus seem to prove with all desirable clearness that there really exists such a current across the polar regions as that the existence of which we have assumed, from our knowledge of the currents of the northern seas. But there is other and even better evidence on which we can base our belief in the existence of such a current. Several years ago a "throwing-stick" or "harpoon-thrower" (a handle used by the Eskimo for throwing darts) of a peculiar shape was found on the west coast of Greenland, near Godthaab, and was afterwards given by Dr. Rink to the ethnological museum of Christiania. At first nobody knew whence it could have come, but on closer examination it appears that the only place where throwing-sticks of a similar shape occur is in Alaska, in the region of Port Clarence, Norton Sound, and the Yukon delta. The throwing-stick is, moreover, ornamented with Chinese glass beads which the Alaskan Eskimo get from the Asiatic side of Bering Strait. Thus it can have no other home than the west coast of Alaska, and it can only have reached Greenland in the same way as the objects from the *Jeannette*.

The best proof that the current must be constantly running from the sea north of Bering Strait and the Siberian coast, across the polar region, is the considerable amount of Siberian, and to some extent also perhaps of American, driftwood, which every year reaches the coasts of Greenland. The principal part of it is Siberian larch, and also red spruce. I have had the opportunity of examining a great deal of this wood on the west coast of Greenland as well as on the east coast. I have found it floating also on the sea among the floe-ice near Jan Mayen and Spitzbergen. Its appearance generally indicates that it has not been in the water for a very long time. For the Greenland Eskimo this driftwood is a necessity of existence, as it gives them material for all their weapons, implements, boats, sledges, tents, &c. Without it they would be in great distress, but they need not fear in that respect, for fresh supplies of wood are brought them every year by the polar current. Similarly, Siberian driftwood is found on Spitzbergen, especially on its northern coasts, and also *in the sea north of this land among the ice-floes carried southward from the unknown north* by that current against which Parry fought in vain. To this place the wood can only have come across the unknown north from Siberia, after having passed somewhere near the Pole.

A fourth proof that a current is constantly running across the polar regions is the thickness of the ice carried southward along the east coast of Greenland. This ice is much thicker than any other ice masses known in the northern seas. Ice of such thickness must have floated for a very long time in the sea; and as immense masses of similar ice are constantly carried southward, it cannot have been formed in the sea north of Spitzbergen or anywhere near the Pole, for in that case it would not have had time to grow thick in floating to the lower latitudes where we meet it. Along the Siberian coast, as well as in the sea north of Bering Strait, the ice is as a rule comparatively thin; during the drift of the *Jeannette* it was found that the average thickness was 7 to 10 feet. This must indeed strike one as being very strange, considering that the sea near the New Siberian Islands is part of the coldest region known on the earth. The reason is evidently that the ice of these seas is not generally more than one year old, as it is every year carried northward by the currents. It seems, then, to be a natural conclusion that it is the same ice which we find again in the East Greenland polar currents, and which has grown thicker on the way across the polar regions.

Quite recently I have received an interesting and remarkable confirmation that this conclusion as to the origin of the thick ice is right. During my last expedition to Greenland I collected samples of dust and mud from the ice-floes between Iceland and Greenland. These samples were some time ago sent to the Swedish geologist, Dr. A. E. Törnebohm, in Stockholm, who has now examined them, and found about twenty various minerals in them. The great variety of these minerals is striking, and in a letter to me Törnebohm says: "Can it be possible that the terrestrial portions of the dust originate from northern Siberia? that it is partly mud carried into the sea by the great Siberian rivers? The great variety of minerals contained in the dust seem to me to indicate that it originates from an extensive land region, and thus it seems most natural to think of Northern Siberia." At this remarkable conclusion has the Swedish *savant* arrived, as he states in a later letter, only judging from the nature of the mud itself, and even without knowing my views as to the polar current and the origin of the ice. But the more valuable is the opinion of such a prominent geologist. As will be understood, I quite agree with Dr. Törnebohm on this point, and I do not think there is room for much doubt, as some parts of the mud occurred in such thick and local layers that they could hardly have been brought on to the ice by anything but water. Even more interesting than the above-mentioned is, that a considerable part, or about the half, of the mud was of organic nature, mostly humus, which indicates that it originates from a soil containing much humus. It can consequently not be glacial mud carried out on the ice by the rivers of Greenland or other Arctic countries; it must have come from some other coast of

the polar sea, and we are again led to Siberia as the nearest and most natural home. Most interesting is, however, in my opinion, the diatoms found in some samples of dust from the surface of the snow of the floes. These have been examined by Prof. Cleve, of Upsala, the great authority on diatoms. He says of them: "The diatom flora of this dust is quite peculiar, and different from that of all the many thousands of samples which I have examined with the exception of one, with which it shows the most complete congruity, viz., a sample which was collected by Kjellman (during the *Vega* expedition) on the floe-ice at Cape Wankarema, near Bering Strait. The species and the varieties are completely the same in both samples." Prof. Cleve has been able to determine sixteen different species and varieties. All these were also found at Cape Wankarema, and *twelve of them are only known from there, and from nowhere else in the whole world;* and that though the diatom flora of the Kara Sea, Franz Josef Land, Spitzbergen, and Greenland has also been partly examined. Cleve is certainly right when he concludes his letter thus: "It is quite remarkable that the diatom flora on ice-floes near Bering Sound, and on the east coast of Greenland, are so completely alike, and so unlike all others. It indicates that there is an open communication between the seas east of Greenland and north of Asia." I think this is a most cogent proof of the correctness of my assumption, that the polar ice on the east coast of Greenland originates in the sea to the north of Siberia.

Another interesting proof, of a scientific nature, may also be mentioned here, which perhaps shows that there has been an open communication between the seas north of Europe and near Bering Strait in a post-glacial period. By examination of a great many specimens of pumice found on the shores of Norway, Spitzbergen, and Greenland, Bäckström, a Swedish geologist, comes to the conclusion that they consist of the group of minerals called Andesites, and cannot originate from any volcanic region in or near the Atlantic Ocean, as no pumice of similar structure and composition is now known in these regions. The pumice-stones must, therefore, in his opinion have been carried southward by the polar current, and must either have originated from unknown volcanoes in the polar regions, or from the great Andesitic volcanic regions near the Bering Sea. The latter supposition he thinks to be the more natural, and the pumice-stones have been floated northward by the current through Bering Strait and across the polar regions, along the route followed by the throwing-stick from Alaska. And as great quantities of this pumice-stone occur on the above-mentioned coasts, there must in a post-glacial period have been a constant communication by the aid of sea-currents between the latter region and the place where the pumice originated. As the pumice-stone is found at some height above the level of the sea, 30 to 70 feet, it must have been brought there by the sea in a period when the land had not yet risen to this height above the present shore. If Bächström's supposition is right this

shows that the communication between Bering Strait and the sea between Greenland and Europe is of no very recent date, and has in the post-glacial period been even more extensive than to-day, as the most northern shores of Europe were also favoured with it.

From all these facts we seem fully entitled to draw the conclusion that a current is constantly running across the polar region to the north of Franz Josef Land from the sea north of Siberia and Bering Strait, and into the sea between Spitzbergen and Greenland, and as we have seen, the floe-ice is constantly travelling with this current in a fixed route between these seas. Since such is the case, the most natural way of crossing the unknown region must be to take a ticket with this ice and enter the current on the side where it runs northward—that is, somewhere near the New Siberian Islands—and let it carry one straight across those latitudes which it has prevented so many from reaching.

There are two methods of trying to attain the result I long for. First, to build a strong ship so constructed that it can withstand the pressure of the ice, and living in this ship, to float across with the ice; or, second, to take only boats along, encamp on an ice-floe, and live there while floating across.

My plan is based on the use of both these methods. I have now built a wooden ship as small and as strong as possible; it is just big enough to carry provisions for twelve men for five or six years, besides the necessary fuel; her size is about 600 tons displacement with light cargo. She shall have an engine of 160 indicated horse-power, which will give her a speed of 6 knots, with a consumption of $2\frac{3}{4}$ tons of coal in twenty-four hours. With sails alone she will likely attain a speed of 8 or 9 knots under favourable circumstances. She will consequently be no fast vessel nor a good sailer; but this is of relatively little importance on an expedition like ours, where we shall have to depend principally on the speed of the current and the ice-movement, and not on that of the ship. A ship's ability to break her way through the pack-ice does not at all depend on her speed, but on her steam power and her shape. For it is naturally the thing of importance to get a strong ship, and the most important feature in her construction is, that she shall be built on such lines as will give her the greatest power of resistance to the pressure of the ice. Her sides must not be perpendicular, as those of ships generally are, but must slope from the bulwarks to the keel; or, to use a sailor's expression, her "dead rise" must be made great, so that the floes shall get no hold of her when they are pressed together, but will glide downward along her sides and under her, thus tending to lift her out of the water. The sides of most ships used in the Arctic seas have been almost straight up and down, in spite of which defect they have stood the pressure of the ice pretty well, and many of them have even been lifted completely out of the water, and have for longer or shorter times stood dry on the ice without being damaged. This

practically happens very often with the small sealing-vessels from the north of Norway which catch seals and walrus in the sea round Novaya Zemlya and Spitzbergen. These ships are often built merely of pine-wood, but yet they are lifted on to the ice; the captains think this a cheap way to get a dry dock and make use of the time to paint their ships, &c., until the floes separate again and the ship sinks into the water, so that they can continue their voyage. Though the *Jeannette* had a shape which in this respect was very bad, and though she was an old and not very strong ship, she managed to withstand the ice pressure for nearly two years twenty-one months. It will consequently be understood that a very slight alteration of shape will give us a very strong ship, and one which can scarcely be crushed by the floe-ice if it is properly handled. For the same reason the vessel ought to be as small as possible, as the lighter she is the more easily she will be lifted by the ice, and the less pressure there will be on her sides; it is also easier to make a small ship strong than a big one. A small ship has other advantages, as it is more convenient to navigate and to handle in the ice, and it is easier to find good and safe places for it between the floes.

As great length is a weakness during the pressure and twisting of the pack-ice, the ship ought also to be as short as her necessary bearing capacity will allow. The result of this in connection with the very sloping sides is, that our ship is disproportionately broad compared with her length. Her breadth is about one-third of the latter. Flat sides are avoided as much as possible near the places which will be most exposed to the attack of the ice, and the hull has plump and rounded forms. There are no sharp, projecting corners; every edge is broken and rounded. Even the keel does not project very much; it is almost covered by the plankings, and only 3 inches are visible outside the ice-skin, and the sharp edges are quite rounded. On the whole the ship will, I hope, leave no place for the ice to catch hold of. Round and slippery like an eel, she will escape its cold and strong grasp.

The ship will be pointed at both ends, and, on the whole, she resembles very much a Norwegian pilot-boat, or, as I am told, a Scotch buckie-boat, only that she of course is carvel-built, and that the keel and the sharp bottom are cut off. Her bottom is near the keel, comparatively flat, in order that she shall have something to rest on without being capsized in case she should be completely lifted on to the ice. Both stem and stern are considerably curved in order that the ice shall get no hold there. The stem is also much sloped, because it will then more easily force the ice-floes under her when she is breaking her way through the ice.

The screw can be raised when necessary, and protected from damage in a well. It can also easily be changed if it is broken, and for that purpose we shall carry two reserve screws. This is, as will be known, a

usual arrangement in modern sealers or whalers; but besides this, the rudder can also easily be unshipped and raised through a well. This is, I think, a fortunate and ingenious idea of the shipbuilder, Mr. Colin Archer, and it is a very simple arrangement. The rudder is, moreover, placed so low that it will be entirely submerged even when the ship is lightly loaded. This is so arranged in order that the ice shall not be able to strike it, and thus break it by even a sudden pressure or movement; it will instead meet the strong stern. The latter is the Achilles heel of the sealers and whalers, where the ice may very easily damage them by breaking the rudder. During my last voyage with the *Jason* to the east coast of Greenland we had such an accident, showing how easily it may happen. When the rudder, then, is not so arranged as in our ship, it takes a long time to have it unhooked and another put on, especially when you have no great crew. Our stern is, as usual, furnished with two perpendicular stern-posts, one a propeller-post, the other a rudder-post, made of big oak timbers about 27 inches broad. On both sides of these are bolted very big and strong curved oak timbers, running along the sloping stern upwards to the deck, thus forming in a way a double stern. Between them are the wells, through which the screw and rudder can be lifted. This stern construction is very simple, and certainly exceedingly strong.

The stem is of course also made very strong. It is composed of three big oak baulks, one inside the other, so that the thickness of solid oak is 50 inches. Inside the stem big and strong breasthooks of oak and iron are placed to connect the ship's sides with each other and with the stem. From these breasthooks stays go to the pawlbit, in order to strengthen the stem and divide the pressure. Outside this wooden stem comes an iron one, and outside this again come transverse iron bars and plates, which go some small distance backwards on each side, to protect the wood against the ice.

Both the stem and the stern-posts are, of course, carefully attached to the keel by strong cross and longitudinal iron clamps and wooden knees. When I add that the stern is also protected by an iron sheeting, it will, I hope, be understood that the two extremities of our ship are pretty well protected.

The keel is made of two big baulks of American elm, 14 inches square. As is already mentioned, it will be almost covered by the outer planking, so that there will only be a projection of a few inches. Above the frame timbers are placed two keelsons, one 17 inches and the other 12 inches in height, both bolted together to the timbers and keel.

The frame timbers are made of selected Italian oak, which is very hard. Only naturally-curved timbers are used; such are much stronger than those curved by the help of the axe. These timbers were

originally meant for some man-of-war, and were thirty years ago bought for the Norwegian navy; they may thus be said to be well-seasoned. The thickness of the frame timbers is about 10 to 12 inches; they are ranged in couples, squared, and bolted together, all joints being bound with iron. The pairs of frames are placed almost close together, leaving only a space of 1 to 2 inches between each. These spaces were left in order to give the very dry timbers a little room in case they should swell when they come into water; the spaces are, however, filled with a mixture of pitch, tar, and sawdust, so that if the outer plankings were shaved away the vessel would still remain nearly water-tight.

The ceiling consists of pitch-pine planks, alternately 4 and 8 inches in thickness. It is twice carefully caulked with oakum to make it tight. The planking consists of three layers; first, a 3-inch oak layer, over which another of 4 inches, and finally an outer planking, or "ice sheathing," of greenheart, which increases in thickness from the keel towards the water-line from 3 to 6 inches. Greenheart is, as you will know, a very hard, strong, and slippery wood, well fit to protect the hull against the damage of the ice, its only fault being that it is so heavy that it sinks in water. Each layer was carefully caulked with oakum and pitch in the ordinary way before the next skin was placed on to it.

The whole thickness of sides of the ship is thus 28 to 32 inches —a solid mass of pitch-pine, oak, and greenheart, with a little pitch in between. It will easily be understood that a ship's side of such dimensions and material will alone have a great power of resistance to the pressure of the ice. But this power is, to a very essential degree, increased by the many beams, stays, and strengthenings of every kind placed inside the vessel. How these are arranged will be seen in the diagrams (Fig. 5). There are two decks, an upper and lower one, each of 4-inch red pine. The deck beams are of oak and pitch-pine 10 or 11 inches square. Numerous upright stanchions and stays are placed as supports to the beams and the sides; they unite the beams of the two decks to each other and to the ship's sides. The principle of arrangement of the stays is, that they shall be placed as perpendicular on the ship's side as possible, in order to strengthen these against pressure from the outside, and to divide the latter. For this purpose the perpendicular stays between the beams of the two decks, and between the lower deck-beams and the keelsons, are also very well fitted. As may be seen in the drawings, stays, beams, and the ship's sides are strongly united to each other by large wooden knees and iron. The whole is like one coherent mass, and the ship may almost be considered as if built of solid wood.

The beams of the lower deck are placed somewhat under the water-line, where the pressure of the ice will be worst. In the after-part, above the engine, we were obliged to raise the deck a little, in order to

give room for engine and boilers; but instead the beams are here supported by two sloping stanchions on each side instead of one, so that also this part must be considered as very strong. As the lower deck was raised, we were also obliged to lift the upper one in order to give room for the cabins. These are thus covered by a half-deck, or poop, 3 or 4 feet in height.

The whole ship is divided into three rooms, or divisions, by two water-tight wooden bulkheads, so that if the vessel, in spite of all, should happen to spring a leak, there will still be two water-tight divisions left to keep her floating. She is also furnished with pumps, one of which will be a great centrifugal pump, which may be driven by the engine and put into communication with all the divisions, and thus empty the vessel in a short time in case she should leak.

The most important feature in the rig of a polar vessel ought to be, that it is as simple and as strong as possible, and at the same time it should be light, and make little resistance to the wind when the vessel is steaming. For these reasons we have chosen to rig her as a three-masted fore-and-aft schooner, the sails of which are very easy to handle from the deck, which also is of some importance when you have a small crew not consisting of first-rate sailors only. On the foremast there will also be two loose yards for a square foresail and topsail. The area of her sails will be about 650 square yards. The under-masts are rather high and strong; the mainmast is 82 feet in length, and the topmast is 50 feet. On the top of this is the crow's nest, which thus will be at a height of about 105 feet above the water. It is of importance that the crow's nest be placed as high as possible, in order to get a wide view over the ice.

The quarters for officers and crew are so arranged that the saloon (Fig. 4, S), is in the middle, on all sides surrounded by the cabins (L, L, Fl), the galley (K), and the bunkers (B); thus, by help of these rooms, the saloon is well protected against the cold and moisture arising from the ship's sides. One of the greatest difficulties with the life on board the vessels of most polar expeditions has been, that the moisture of the warm air in the small cabins was condensed on the cold sides of the ship, and was there frozen to ice. The mattresses in the berths on these walls were therefore very often transformed into as many lumps of ice. To avoid a repetition of this has, of course, been of importance to us. We have therefore located the saloon as described in order that we may all live there night and day, in case it should be necessary, during the most severe cold. We shall thus follow the same principle as the Eskimo, living many people in a small room to make it warm; we shall certainly not then want much to heat it.

But besides this, every precaution is taken to isolate the walls and make them warm, and to prevent the moisture being condensed on them. The ship's sides are, on the inner side, covered with tarred felt; then

comes a thick layer of cork; inside this a wooden wainscot; then a layer of felt a few inches thick; next comes a nearly air-tight layer of painted canvas, or linoleum; and then another wainscot. The air-tight canvas is there in order to prevent the warm and moist air from inside penetrating into the layers of felt and cork, and giving off moisture there, thus transforming them into ice. This principle we have followed, on the whole, also in the roof. The walls between the cabins and the saloon are made in a similar way, and the roof and floor are very thick, consisting of many layers. In the roof there is, amongst others, a layer of reindeer-hair a couple of inches thick, which I think must be very effective as a heat insulator, as the reindeer hairs are so very porous and elastic. On the floor and walls may of course also be laid bear-skins and carpets, to make them still warmer. I hope you will get the impression that everything is made to give us a snug and comfortable saloon and cabins, fit for a climate such as we may expect.

The principal dimensions of the vessel are as follows:—Length of keel, 101 feet; length at water-line, 113 feet; length over all, 128 feet; beam at water-line amidship, excluding the "ice-sheathing," 33 feet; greatest beam, excluding the "ice-sheathing," 36 feet; depth moulded, 17 feet; the draught with light cargo is 12 feet; the displacement is then about 530 tons, but when, with heavy cargo, the draught is 15½ feet, the displacement will be about 800 tons. Her freeboard will then be only 3½ feet. Such will probably be the case when we leave the last place where we can get coal, as we will of course then load her with as much as she can carry. We will soon burn a good deal in the engines, and she will gradually be lifted again.

The hull, with boilers filled, weighs about 420 tons. With a displacement of 800 tons, she has consequently a bearing capacity for 380 tons of coal and cargo. Our equipment and provisions will not likely weigh much more than 60 or 70 tons; thus 300 or 320 tons' bearing capacity will be left for coal and fuel, and this is enough for about four months' steaming with full speed. We shall not, however, likely be able to make use of our engines more than two months after we have been loaded with coal for the last time. A great quantity will thus be left for heating and cooking during the winters. For heating purposes we shall also carry petroleum, which has the great advantage of giving light besides. For the cooking we shall carry alcohol.

The vessel was launched at Laurvik on the 26th of October, and was named *Fram*, which means "forward." I hope she will accomplish what this name promises.

Fram will certainly be the strongest vessel ever used in the Arctic regions. She is built with great care, and I feel certain that she can be crushed only in a quite extraordinary combination of circumstances. With this vessel, and a crew of twelve strong and well-picked men, besides an equipment for five or six years, as good in all respects as

modern appliances can afford, I think the enterprise has a good prospect of success.

It is my intention to start next spring. Our first goal will be the New Siberian Islands or the mouth of the Lena River. I have been uncertain whether I will go through the Kara Sea, or will prefer the route from the side of Bering Strait; but think now that I shall take the former. When we have reached the sea north of the Lena delta we shall have to wait for the right moment to go northward along the western coasts of the New Siberian Islands, and try to reach the farthest possible point north in open water. This will probably be in August or the first days of September. The current caused by the warm water from the Lena River will certainly be a great help to us, as it seems to be of great influence during the summer, producing an extensive open sea, in which one of the boats from the *Jeannette* was even wrecked. To be able to navigate the ship properly through the ice I thought of using captive balloons. By help of these we could easily in clear weather get a splendid view over the surroundings, and see where there is ice and in what direction there is open water; we should then in a moment see what direction to take as clearly as if we had it traced on a chart, and should lose no time by trying in a wrong direction. The great difficulty is, that there is very much fog in this region just on account of the warm Lena water; but a good clear day with balloon work would then be the more valuable, and would make up for a great many others with fog. A still greater difficulty is, however, that the balloon equipment, especially the steel cylinders with the compressed hydrogen, are so heavy that I fear it would be too difficult to carry them in our small ship, and as they are also very expensive, I fear I shall have to give them up.

When we can get no farther we shall have nothing left but to run into the ice at the most favourable spot, and from there trust entirely to the current running across the polar region. The ice will perhaps soon begin to press, but it will only lift our strong ship. While drifting we shall have plenty of time and excellent opportunity to make scientific observations. Probably we shall in this way, in the course of some years, be carried near the Pole, or across it, and into the sea between Spitzbergen and Greenland, where we shall get into open water again, and be able to return home.

There is, however, a possibility that the ship, in spite of all precautions, may be crushed in the ice; but if this happens the expedition will have another resource. It will now be time to use the ice as quarters instead of the ship, and we shall have to move all our provisions, coal, boats, &c., to an ice-floe, and camp there. Besides the light ordinary boats I have built two big boats for this purpose, 29 feet long, 9 feet broad, with flat bottom, and so deep that we can sit and lie comfortably inside them. They have a deck, and are so big that the whole crew can live

even in one of them. These boats will be placed side by side on the ice, will be covered with thick warm tents and snow, and will give us two good warm saloons. Thus we can continue our journey. There is certainly no reason why one should not be able to live comfortably enough in this way if one is only prepared for it. The only difference will be that we have now got two small ships standing on the ice instead of the big one lying between the floes. When we emerge into open water on this side of the Pole there will not be any great difficulty in returning home in our boats; such a thing has been done many times before.

It is my conviction that the only difficulty will be to get duly into the current north of Siberia; when this is fortunately done, we must be carried somewhere northward. There is no case in which a ship has been nipped in the pack-ice without being carried in some direction. Whether we will succeed or not, I feel convinced that this is the way in which the unknown regions will some day be crossed. To travel in this manner is certainly no new fashion; it has been tried many times before. I need only remind you of Sir Leopold M'Clintock's drift with the *Fox* during eight months in the winter of 1857-58, when he drifted 1200 miles from the northern part of Baffin's Bay down towards Labrador. Several years later (1872) a party from the *Polaris* expedition drifted on an ice-floe even a longer distance very nearly along the same route. Along the east coast of Greenland many such ice-drifts have occurred. I may remind you of the whole fleet of whalers—about twenty-eight in number—which in June, 1777, were nipped between lat. 74° and 75° N., and which drifted in the ice southward along the whole East Greenland coast. The last ship was crushed in October, in lat. 61° 30′ N., after having drifted a distance of 1250 miles in 107 days. Some of the men continued the drift on the ice, rounded Cape Farewell, and reached at last the Danish settlements on the west coast, their whole drift being about 1600 miles or more. In the winter of 1869 and 1870 the *Hansa* crew drifted on an ice-floe, as you will remember, along the same coast, very nearly the same route, and the same distance as the whalers in 1777, until they, after nine months, arrived safely at a settlement west of Cape Farewell. During our attempt to land on the east coast of Greenland, in 1888, we also, as will be known, had some little experience in this drifting, and in 1882 I also tried a little of it with a Norwegian sealer.

In the sea between Novaya Zemlya and Franz Josef's Land the Austro-Hungarian expedition in the *Tegetthoff* drifted for a period of one year and a half; but as I have already mentioned, a striking difference between this drift and those above-mentioned is, that it had no southern direction, it went *north-east*, *north*, and *north-westward*. In this respect the drift of the *Jeannette* during two years from a point to the north of Bering Strait is also most remarkable, as it went in a *north-westerly* direction.

It will thus be seen that drifting in the ice is no new mode of travelling in the Arctic regions, neither is it new to make discoveries in this way. During the drift of the *Tegetthoff* the most important Arctic discovery of recent times was made, viz., Franz Josef Land, and during the drift of the *Jeannette* several islands were discovered. The only new feature in my plan will be, that *I wish* to be drifted, while these previous expeditions drifted *against* their will.

There is a possibility that we may be stopped by unknown lands near the Pole, or that we may strike an eddy or a side current, but we hardly run any great risk in any of these cases. If, in the former case, we should fail to get our ship afloat again, we should have to leave her and strike out for the nearest current to drift on again, or return homeward travelling over the ice. When we only take care to travel with the current and not against it there will certainly be no special difficulty in doing this; and if the distance should be too great, we should leave all boats, taking only light sledges with necessary provisions, &c., besides canvas for boatmaking, walk on until we reached Spitzbergen or any other land where there is open water. Here we would make boats of canvas, or if possible of the skins of seals or walruses, like that we made when we reached the west coast of Greenland. If we are caught by a side current this must at last bring us somewhere; it cannot for ever run in a ring near the Pole; and wherever we come near the coasts of the Polar Sea we shall have no difficulty in returning home. It may be possible that the current will not carry us exactly across the Pole, but *the principal thing is to explore the unknown polar regions*, not to reach exactly that mathematical point in which the axis of our globe has its northern termination.

The only experience which can give us some idea as to the time the current will require to drift the expedition across is the drift of the relics from the *Jeannette*. If we assume that they required one year for the drift southward along the east coast of Greenland from latitude 80° N. only two years remain for the rest of the journey, and this requires a speed of no more than two nautical miles daily. This does not seem too high a rate when we remember that the *Jeannette* drifted at the same speed the last half year of her drifting. It cannot therefore be considered improbable that we should reach open water on this side of the Pole within two years after our start from the Siberian side. One cannot, however, expect that the course will be one straight line forward during all this time. There will certainly come periods during which the drift is quite stopped, or when we may even be carried backward, and the route and time can thus easily be lengthened; but when we, as already mentioned, take provisions for five or six years we may consider that we have an ample margin. This may perhaps seem to many to be a long time, but there is a great advantage in this route, and that is, that when the expedition is once well begun there will not be much help in looking

backwards; our hope will then lie on the other side of the Pole, and such a knowledge is a good help to get *Fram*, or forward.

There are a great many things in our equipment which ought also perhaps to be mentioned; but as this paper has already become so long, I shall only mention a few of the most important points.

To get fresh food we will shoot as much as possible, and for this purpose we will carry light sealing boats as also Eskimo kayaks. The use of these excellent light craft I learnt to appreciate in Greenland; they are very good to shoot and fish from, can easily be carried long distances over the ice, and can be used wherever there is a little open water.

To make excursions over the ice in case we shall meet with land—which of course is very likely—we will take dogs, sledges, "ski" and snow-shoes with us, besides full equipment for sledge-travelling. I hope to spend a great deal of the time in this way by making excursions in all directions where anything of importance may be expected. For entertainment during the long winter nights, as well as for all kinds of scientific work, a good library will naturally form a most important part of our equipment.

Our scientific equipment will be chosen with the greatest care, and the best instruments accessible will be taken. I shall not, however, tire you with an enumeration of them; they will naturally, to a great extent, be much like what other Arctic expeditions have had. I may only mention that I have also got a pendulum apparatus and the necessary astronomical universal instrument, in the hope that we may get some opportunity of making pendulum observations on northern latitudes, which is of course of the greatest interest.

One of the greatest difficulties we will have to overcome will perhaps be the scurvy. It has been very bad on many previous expeditions, and during the long time we expect to be away it is not impossible that it might occur. I do not, however, consider this to be very probable. I am examining the question very closely, and all possible precautions are being taken to avoid it. In our time science ought to be able to produce an equipment as regards provisions which will make scurvy an impossibility. It is a ghastly enemy, that is true, as we do not know its nature and origin. But it seems as if it almost never occurs except in connection with badly-preserved meat, and especially salted meat, and I cannot understand why then we should take such a thing with us; there is plenty of other things to choose among. Alcoholic drinks will of course not be taken.

To live a healthy life in all respects is naturally very important. Two of the principal conditions to keep one's health are, heat and light. In order to produce the necessary heat, we live together in a small room during the coldest season, as is already mentioned. We will also have good warm clothes. Woollen ones I regard as best for indoors, but in

the open air, skin or canvas suits to put outside the woollen clothes are necessary to protect one against the biting wind and the snowdrift. To heat our saloon there will certainly not be much wanted even during the severest cold. A few paraffin lamps or a small paraffin stove will certainly be sufficient. There will of course also be care taken to get good ventilation. We thus run no risk, I think, of suffering from the want of heat. With the light it is, however, worse. Almost no organism can exist without that, and therefore various illnesses occur during the long Arctic nights. This it would seem difficult to avoid in regions where the darkness lasts six months. I believe, however, that we shall be able to overcome this difficulty also by help of the wonderful electric light. We shall have a dynamo for producing electricity. Many will perhaps ask how we shall get the necessary power to make it work. This cannot, however, be difficult. On one hand we have the wind. The meteorologists are certainly of opinion that this will not, as a rule, be very strong in the cold over the Polar Sea; but a little we must find there also, and if the sails of our windmill are made sufficiently big, we do not want much to turn them. But even when there is no wind at all we will be able to produce power. We are twelve men, strong, and well-picked, as I hope, and when a capstan is arranged on deck we will be able to do work similar to that which a horse does in its horse-mill on land. In this capstan four men take their turn at a time; thus we will obtain good and regular exercise—somewhat monotonous perhaps—and will at the same time be useful by producing electricity, so that we can have an electric arc-lamp burning eight hours a day. Everybody will understand what a blessing that must be when one is surrounded by constant darkness. When the sun begins to sink to disappear behind the horizon in the south for the last time we begin to walk in a ring in the darkness on the deck of our ship, in order to produce a new sun. In this way we will slowly move forward. I hope that you, ladies and gentlemen, will sometimes send us a kind thought while we go round in our mill there far north in the solemn silence of the long polar night.

Admiral Sir Leopold M'Clintock: I think I may say this is the most adventurous programme ever brought under the notice of the Royal Geographical Society. We have here a true Viking, a descendant of those hardy Norsemen who used to pay this country such frequent and such unwelcome visits. One cannot but admire Dr. Nansen's splendid enthusiasm. He has adduced some very striking proofs as to the current to which he intends to trust himself and his companions; he has shown us that the current is proved to extend to the north-west from Barents Strait, at least to lat. 77°; has reminded us of the Dutch fleet frozen in on this side the Pole in lat. 78°–80° between Spitzbergen and Greenland, and which drifted south, sometimes in sight of Greenland, sometimes in sight of Iceland, until the last one was crushed somewhere near Cape Farewell. Thus we have a north-west current running in, and a south-west current running out, and the unknown intervening space, the so-called Polar Basin, is 1500 geographical miles; and this is just

the space which has so many attractions for Dr. Nansen, that he proposes to drift across it. I wish to say only a few words, and those with reference to the minor currents, with which I am personally acquainted or have had some experience. We find on the American Islands an enormous pressure of Polar ice, very different in character from anything further south, pressing in from the west and choking up all the channels between them, up to 83° N.; but though this heavy ice bars the channels, it does not stop the flow of the current underneath, which runs into Baffin's Bay and so gets into the Atlantic Ocean; and this may have some bearing upon Dr. Nansen's current. I sincerely trust Dr. Nansen will succeed in getting into mid-current north of the New Siberian Islands, because then he will be in less danger of being impeded by all these American Islands on the one hand, and Spitzbergen and its neighbouring islands on the other, whereon are cast great quantities of Asiatic timber—trees brought down by the Siberian rivers; so I suppose as Siberian driftwood can be carried, Dr. Nansen's ship could be carried, and I hope he will come straight through. But all these dangers are very small as compared with the dangers of the ice to which he proposes to trust himself. This great Polar ice is so much heavier than that which is met with in Straits, or in Baffin's Bay, which discharge their ice annually into the Atlantic. De Long was beset in one year's ice about 6 feet thick; nearly two years later with the same ice, which had grown very much thicker round the ship, the *Jeannette* was crushed. At that time the thaw had not commenced, and the ice was still firmly frozen to her sides, so that for the ship to have been pressed up, would have been an exceedingly difficult operation. The ice imprisoned in this Polar basin for some years grows thicker from year to year. Dr. Scoresby tells us that the great ice fields in lat. 80° average in thickness 10–24 feet, and where hummocks occur it is often up to 40 feet or even 50 feet. By the crushing of the floes these great masses are pressed against each other, and overlaying, get frozen together, so that there may be almost any thickness of ice. Dr. Nansen has very fully described his ship to us, and I think she should accomplish all that any vessel could do. He attaches much importance to the wedge shape of the vessel under water, where the ice pressure will tend to lift her up. My own last Arctic vessel the *Fox* was precisely of that build: and the rotten ice, not more than a foot above the surface of the water in summer-time, would crush against her sides, pass under her, and still crushing against the wedge-shaped bottom, tend to lift her up, and so she frequently escaped from being crushed. I am glad to say she was never squeezed by the ice during the winter months, when the ice was of quite a different character—more like rock frozen fast to the ship's side. The possibility of sliding up on to the ice is then, I think, very remote. Dr. Nansen has alluded to his boats, 29 feet long, as being convenient for the reception of his men on the ice. I would prefer much more portable boats, such as could be readily and quickly removed from any position of danger; for these floes are so frequently rushing against each other and crushing together, that what is safe at one moment may half an hour afterwards be extremely unsafe; it is better, therefore, to have portable boats, and I would trust to snow huts built upon the ice, for shelter in the extreme cold. While I wish Dr. Nansen complete and speedy success, it will be a great relief to his many friends in England when he returns; and more particularly to those who have had some experience of the dangers at all times inseparable from ice navigation, even in regions not quite so far north.

Admiral Sir GEORGE NARES: It is a delicate duty to criticise the details of any voyage fully determined on, and is especially so in regard to an exploring voyage to be undertaken by another nation. But as Dr. Nansen has submitted his programme to this Society, the Arctic members are bound to give you

their opinion. In anything I say Dr. Nansen may be sure that it is said in a friendly spirit, with the greatest admiration of his plucky proposal, and his powers of endurance and readiness of resource under extreme circumstances, as displayed in the past. I would also say at once that, whatever the result of the voyage may be, we are satisfied that he will give us on his return a good account of such parts of the Polar area as he may reach. The adopted Arctic axioms for successfully navigating an icy region are, that it is absolutely necessary to keep close to a coast-line, and that the farther we advance from civilisation the more desirable is it to insure a reasonably safe line of retreat. Totally disregarding these, the ruling principle of the voyage is that the vessel—on which, if the voyage is any way successful, the sole future hope of the party will depend—is to be pushed deliberately into the pack-ice. Thus her commander—in lieu of retaining any power over her future movements—will be forced to submit to be drifted helplessly about, in agreement with the natural movements of the ice in which he is imprisoned. Supposing the ocean currents are as stated, the time calculated as necessary to drift with the pack across the Polar area is several years, during which time, unless new lands are met with, the ice near the vessel will certainly never be quiet, and the vessel herself never free from danger of being crushed by ice pressure. To guard against this the vessel is said to be unusually strong, and of a special form to enable her to rise when the ice presses against her sides. This idea is no novelty whatever; but when once frozen into the Polar pack the form of the vessel goes for nothing. She is hermetically sealed to, and forms a part of the ice-block surrounding her. The form of the ship is for all practical purposes the form of the block of ice in which she is frozen. This is a matter of the first importance, for there is no record of a vessel frozen into the Polar pack having been disconnected from the ice, and so rendered capable of rising under pressure as a separate body detached from the ice-block, even in the height of summer. In the event of the destruction of the vessel, the boats—necessarily fully stored, not only for retreat, but for continuing the voyage—are to be available. This is well in theory, but extremely difficult to arrange for in practice. Preparation to abandon the vessel is the one thing that gives us the most anxiety. To place boats, &c., on the ice packed ready for use involves the danger of being separated from them by a movement of the ice, or of losing them altogether should a sudden opening occur. If we merely have everything handy for heaving over the side, the emergency may be so sudden that we have not time to save anything. So the only feasible plan is to arrange for sledges, boats, stores, &c., to be as accessible as possible, and, in the words of De Long, "Stick to the ship as long as she will stick to us, and when she is ready to leave us try to be a little readier to leave her." As to the direction of drift of the Polar ice we all agree with Dr. Nansen as to the southerly movement of the water between Spitzbergen and Greenland. We may, therefore, accept the homeward carrying current on which he proposes finally to depend. He has, in my opinion, overstated its depth; but that does not in the least affect his main deductions. We may also infer that a similar movement of the water, with a reducing velocity, will be met with north and north-east of Spitzbergen for a distance of 500 or 600 miles—that is, to about as far as the Pole itself. Of the other water movements, there is the current from the Atlantic towards the Barents Sea. This is proved by the drift of Weyprecht and Payer to be so slight that it was completely overpowered by the wind pressure. The wind it was that carried them to Franz-Josef Land. Again, the reported Bering Strait current has so slight an effect along the Siberian coast that De Long—in the *Jeannette*, and while retreating south over the ice—was similarly drifted about by the prevailing winds, and by them

only. De Long frequently refers to the fact, and his final record left on the ice after the vessel disappeared states—"As the prevailing winds are from the south-east, this ancient ice moves slowly along to the north-west. There are no currents which are not caused by the wind prevailing at the time." There remains for consideration the effect of the fresh water discharge from the rivers. This, doubtless, exerts an influence some distance seaward, but only during the summer and autumn; and even then the largest cannot cause any appreciable movement in the ice farther than about 200 miles from the mouth. Beyond this distance seaward, the wind-drift must overpower that produced by any other means. As to the probable direction of the drift, the *Fram*, starting from near the mouth of the Lena river, may expect to meet the main pack no farther north than about lat. 76° 30′. I doubt her getting farther north before she is beset; but, taking an extreme case, and giving her 60 miles more, she will then only be in the same latitude as Cape Chelyuskin—730 miles from the Pole, and about 600 miles from my supposed limit of the effective homeward carrying ocean current. After a close study of all the information we possess, I think the wind will be more likely to drift her towards the west than towards the east. With an ice-encumbered sea north of her, and more open water or newly-made ice to the southward, the chances are small for a northerly drift, at all events, at first; and, afterwards, I know of no natural forces that will carry the vessel in any reasonable time much farther from the Siberian coast than the *Jeannette* was carried, and, during the whole of this time, unless protected by newly-discovered lands, she will be to all intents and purposes immovably sealed up in the pack and exposed to its well-known dangers. There is no doubt that there is an ocean connection across the area proposed to be explored. In conclusion, I join with Dr. Nansen in considering that the principal aim of all such voyages is to explore the unknown Polar regions, not to reach exactly that mathematical point in which the axis of our globe has its northern termination, and I offer him my hearty wishes for a successful voyage.

Admiral Sir E. Inglefield: After the remarks made by the distinguished Arctic navigators who have just spoken there is little for me to say. I think I can give Dr. Nansen a word of encouragement by telling him that on my second voyage I walked up one shore of Wellington Channel to meet Sir Edward Belcher, and one evening we were lucky in finding a pine tree one foot in diameter, and about—as far as I can remember—15 to 16 feet long, with the bark upon it, and very little bruised. We know it can have come from no other part of the world but Siberia. I may add that a portion of the bark of that tree was brought home, and the naturalist with a microscope discovered seeds and matter upon it which assured him it had not been more than a few months in the water. This was on the western shore of Wellington Channel, which, as everyone knows, runs into Baffin's Bay. I made three voyages to Beachy Islands, &c., the first in a little yacht of 150 tons, the others in Government vessels of 800 tons; and I may say that if I had to go again I would prefer the 150-ton vessel.

Sir Allen Young: I am called upon unexpectedly to say a few words, and really after what we have heard from Sir Leopold M'Clintock and Sir George Nares there is little left to say. I believe there can be no doubt that these relics from the *Jeannette* were genuine, and must have drifted on the floe on to which they were thrown when the ship was abandoned, and could have come to the Greenland coast in the time, by no other way but across the Pole, or nearly so. Dr. Nansen assumes that the blank space around the axis of the earth to be a pool of water or ice; I think the great danger to contend with will be the land in nearly every direction near the Pole. Most previous navigators seem to have continued seeing land again and again further and further north. These *Jeannette* relics may have

drifted through narrow channels, and thus finally arrived at their destination; and, I think it would be an extremely dangerous thing for the ship to drift through them, where she might impinge upon the land and be kept for years. It is only to be hoped that Dr. Nansen will be equipped with such gear as to enable him in case of disaster to retreat to open water; and I quite agree with Sir Leopold M'Clintock that these large boats will not be available for that purpose. With reference to land about the Pole I may mention that when I was at Upernavik on the west coast of Greenland, the Governor had a reindeer skin which had been branded with a mark like those which the Siberians use for their tame reindeer, and tame reindeers are unknown in Greenland; therefore this reindeer must have come from the coast of Siberia, either round the north point of Greenland or across the inland ice. It must have come across islands stretching from some point in Siberia; and this goes to prove that there are islands on the way. We know, of course, that the Gulf Stream washes the shores of Norway, and also Novaya Zemlya, and turns again to the westward, as is evidenced by the fact that glass balls used by the Norwegian fishing-boats are found on the west coast of Greenland. It reaches, perhaps, to Franz Josef Land; but further we know nothing save from the relics of the *Jeannette*, which afford strong proof of the existence of such a current. Dr. Nansen says that the *Jeannette* was not a strong ship. I am glad to say that I found the *Pandora*, as she then was named, an extremely strong ship. We had some severe nips, and yet the ice did not come through her, although on one occasion some of her beams were broken. In my opinion she was too strong; for had she not been so strong she would have been crushed in the first winter, and those heroic men who have gone and whose loss we all deplore, would have been still with us. I do not think the form of the ship is any great point; for when a ship is fairly nipped the question is if there is any swell or movement of the ice to lift the ship. If there is no swell, the ice must go through her whatever she is made of. The great danger to the *Fram* is in case she is impinged against some land and there remains. I hope Dr. Nansen will start from the west of the New Siberian Islands, because island after island were discovered by the *Jeannette*, and if he commences his drift from the north or north-west of these islands, he will start on a fairer basis than from the eastward. I only wish Dr. Nansen a most happy voyage, and that he may get through, and soon be with us again.

Captain Wiggins: It is so late that I cannot say all I should like to say upon this most interesting question of Dr. Nansen and his glorious scheme. It gives me great pleasure to meet Dr. Nansen for the first time. I have never had the pleasure of shaking hands with him yet, but I shall not allow him to leave this platform until I do. I should have liked to have seen the track shown on the chart; I understood he was to go by Bering Strait and to the north of the New Siberian Islands in the track of the *Jeannette*. With such a route I could not see my way clear to say one word in favour of Dr. Nansen's adventurous voyage. I have heard since from his own lips that he rather contemplates going by waters nearer home, and what is of more importance, taking up what I recommended in 1876, the route inside Novaya Zemlya through to the Kara Sea, thus taking the full swing of the Gulf Stream, which we know flows in there with great force and regularity; and it must go somewhere. To those seas I have been seven or eight voyages, and never yet returned on account of ice. The thermometer there shows us 45° to 50° Fahr. in the water passing through the Straits. I cannot to-night say one-half of what I should like to say, but if I could have the honour of doing what I have never done in this room—reading a paper—I could, in an hour and a half, make it very clear that it might not be impossible to take the ice and cross the regions of the Pole, if not the Pole itself. As I pointed out in 1876, I found open water all the

way to Dickson's Harbour in 1874–75, and I believed the best course to the Pole would be through the Kara Sea, not further east than the Chelyuskin promontory, i.e., 100° long. The only risk will be, as Sir Allen Young pointed out, the question of land. No doubt land will be found distributed about the Pole more or less, even shoals. It has been found before, not only by the *Jeannette*, but by the Austrian expedition in the *Tegetthoff*, which I had the honour of searching for in 1874 in the *Diana;* and when I found them at Hammerfest they acknowledged I was quite right in advising them to go inside the Kara Sea. I felt certain the best currents were there; and along the Siberian shore there are always natives who could help. De Long did not lose his life for want of natives, but by exposure in the boats; he perished at the mouth of the Lena by the storms; the two men who escaped easily found the natives. I would advise Dr. Nansen not to take the New Siberian Islands, as they are most treacherous, low, sandy, muddy, horrible places, and on account of the Lena, there is broken water all the year round, and that is bad for sledging. Baron Wrangel found open water there in midwinter. With regard to going on the top of the ice I am at one with Dr. Nansen, the only difference being that I believe in small things. I did my first voyages in the *Diana* of 120 tons, and was crushed upon the top of the ice, and in my ignorance, in 1874, rammed the ice in splendid style, and had some hair-breadth escapes, having entered the Kara Sea too early in June and July. I should recommend instead of so large a vessel a smaller one, or to take a small one with him, as with a small vessel you can do much more on the top of ice than with a large one. A vessel may rise when it is squeezed by the ice, though the chances are much against it. The *Tegetthoff* rose until her keel was on top of the ice, like the model of a steamer on a table. I should recommend, if there is room, not to wait for a squeeze, but to run the vessel as far on top of the ice as possible. A small vessel of 20 or 30 tons might be easily hove round a headland like a huge sledge on the top of ice-floes. If I were going now I would take three small vessels—or at any rate two—as being better than one big one. I should recommend Dr. Nansen to go through the Kara Sea, and on the 100th parallel the current would be always with you. I wish him God speed.

Captain WHARTON, R.N.: At this late hour I will say a very few words. As I have not Arctic experience I suppose I am called upon as the professional guardian of the currents of the world, and all I can say on that point is that so far as Dr. Nansen has spoken about the currents that are known he is correct. He speaks of articles thrown upon the coast of Greenland: that is according to fact. As regards the ice I cannot tell you anything. I believe, after close investigation into known currents, that Dr. Nansen is quite justified in supposing there is a drift from the New Siberian Islands, or that side to Greenland, but as to its direction or speed that, as he has told us, is pure speculation. He is not going into this matter with his eyes shut. He has argued the question out very closely, and given us an admirable paper. People sometimes ask, What is the use of Arctic exploration? Amongst other things I think it may be said that its use is to foster enterprise and bring gallant men to the front. To-night we have an excellent example of that in Dr. Nansen. I can only say to him, "God speed."

The PRESIDENT: It is very late, and although there are still many eminent Arctic travellers present—Admiral Ommanney, Dr. Rae, and others—I think it will not be your wish to hear any further speakers. I ought to mention, however, that I have received a long letter—too long to read—from Sir George Richards on this subject; and, although admiring Dr. Nansen, he is obliged to speak unfavourably of his project, adding that anyone speaking with authority ought to speak out when so much is at stake. Dr. Nansen will perhaps like to answer in a few words, and then the meeting will close.

Dr. NANSEN: I use this opportunity to express my most hearty thanks to those eminent Arctic men who have given their opinions and criticism upon my scheme to-night. I must, at the same time, say that I could get no better encouragement for my expedition, because their criticism has not been able to convince me that I am wrong in my opinion about the currents or about the expedition. Sir Leopold McClintock, Sir George Nares, and Sir Allen Young say that it would be impossible for the ship to be lifted during the winter, but that it would be frozen in. Well, I will not detain you by giving you my opinions about that, but will only say that we have, as Captain Wiggins mentioned, one very good instance of a ship being lifted during the winter, viz., the *Tegetthoff*. She was lifted so high that her keel was above the surface of the ice. That, in my opinion, is enough to prove that the vessel can be lifted even in the winter, and that she may drift in the ice for years without being crushed, if she is only strong enough to withstand the pressure necessary to lift her. The *Tegetthoff* indeed, was safe when she was deserted because of the fear that she would not move again. It is also maintained that my boats are too heavy; but I had not the time to read all about the equipment of the expedition, or I could have told you that I am going to carry about ten boats of various sizes, and some of these will be exceedingly light. Of course, the heavy boats are only to be placed on the ice for living in, because the small boats are too small to live in comfortably. Sir George Nares said he thought an Arctic expedition should always secure a line of retreat. I am of the opposite opinion. During my expedition to Greenland I proved that it is quite possible to accomplish something when you have no retreat, for we then burned our ships behind us, and, in spite of it, got across Greenland; and I hope to be as successful when we break the bridge behind us this time, if no other circumstances intervene to prevent us from getting through. Sir George also referred to the great risk run by the boats through floating ice. I refer you to the experience of the *Hansa* Expedition. They kept their boats for a whole winter drifting south along the east coast of Greenland, and when the hut they built of their coal was broken by the breaking up of the ice they took refuge in their boats, sleeping on board during the nights for safety; so I do not think it impossible to keep boats safe on the ice if you only take proper care of them. This was also my experience in drifting along the East Coast, and we had some bad experiences. The worst thing in that respect is, in my opinion, not the ice, but the surf, and we run no risk of that in the Arctic regions when surrounded by ice. As to the winds:—I mentioned in my paper, that according to my opinion the winds will not be against us, but in favour of my scheme; in fact, the wind is the principal cause of the currents, and if we can say with certainty that a definite current is constantly running in a distinct direction, we may as a rule conclude that the average direction of the winds go the same way; but I think we need not go further into this question at present, as we actually know very little of the winds in the unknown Arctic regions; the only experiences of much importance in this respect are those of the *Tegetthoff* and the *Jeannette*, and they do not seem to speak in my disfavour. In my opinion Sir George Nares was not able to prove that my arguments for the existence of such a current as I assume were wrong. Sir Edward Inglefield was kind enough to mention the finding of drift-wood from Siberia on the shores of Wellington Channel coming from the north. So long as that and similar evidences are undeniable facts, I think it shows that there must be ice constantly floating across, as the drift-wood cannot dive under the ice. As regards the ice conditions, at the New Siberian Islands I have received some information from Baron von Toll, who has spent two years there, and I regret time will not allow me to give you details; but the sense of it is that the sea generally is open to the west of the New Siberian Islands during August. How far north that prevails nobody

knows, but in my opinion it cannot be a short distance, as the River Lena sends out a quantity of fresh warm water during the summer into the shallow Polar Sea, and produces a current running north. I thank Sir Edward most heartily for the proof of the current he has given. I quite agree with Sir Allen Young that one of the greatest risks is to meet land, and as I said in my paper it is very likely that we will meet land further north. The *Tegetthoff* expedition was stopped by land, but I do not think that such a thing is likely to happen very often; if there is land in the north it is, of course, quite possible that we may drift against it, but the probability is that the current shall carry us past it, as it does with most part of the ice; and this will become the more certain if we get into the heart of the current; but if we are stopped we have nothing to do but to leave the ship and travel on with the current. If we only keep with the current and do not go against it I do not think it impossible to reach open water and get home in that way. I must thank Captain Wiggins for his most interesting remarks, but I must say I never thought of taking the *Jeannette* route; my idea was at first to go through Bering Strait and along the Siberian coast to the New Siberian Islands, and thence go north, as I thought that it would be easier to reach these Islands that way than through the Kara Sea and past Cape Chelyuskin. By examining the question more closely, I have come to the conclusion that the advantage of this first route is not quite certain; and then, of course, I prefer the shorter one through the Kara Sea. I quite agree with Captain Wiggins that the best route to follow is to keep as much to the coast as possible; therefore my ship was made to draw as little water as possible in order to be able to travel inside the ice along that shallow coast. Captain Wiggins recommended a small ship; I think a ship 29 feet long ought to be small enough, and I have two such small ships. I will conclude by thanking the Geographical Society and the English Arctic explorers for the cordial way in which they have received me and my scheme.

The PRESIDENT: You have listened to Dr. Nansen, you have admired his foresight in anticipating and providing against difficulties, his resource, his ingenuity in details, his courage and his enthusiasm. You have heard the views of some of our greatest Arctic authorities. The views of some others which there has not been time to read, including those of Sir Joseph Hooker, whose experience was gained in the Antarctic regions, and as I have already mentioned, those of Sir George Richards will be laid before you in *The Geographical Journal*. Dr. Nansen will no doubt reflect upon what has been said and written, but for the members of the society at large to pronounce any definite opinion upon such keenly-disputed questions as are involved in Dr. Nansen's plans would be out of the question; what we can do is to assure him of our most cordial good wishes and to give him as I now do our warmest thanks for his paper.

The following communications have been received from Admiral Sir George H. Richards and Sir Joseph D. Hooker, who were unable to be present at the meeting:—

I venture to offer a few brief remarks on the paper which has been read by the distinguished Greenland traveller and explorer, Dr. Nansen. Dr. Nansen, in his paper, deals mainly with the currents, known and unknown, in the Arctic regions, and he appears to trust almost entirely to their influence for the accomplishment of his object in reaching the Pole, or rather in being drifted from a position near to the New Siberian Islands, across the Pole to Greenland, a distance, in a direct line, of about 1400 miles. Now to make myself clear I must give in a few words my views of these currents. I believe that there is a constant outflow (I

prefer this word to current) from the north in consequence of the displacement of the water from the region of the Pole by the ice-cap which covers it, intensified in its density by the enormous weight of snow accumulated on its surface; this outflow is doubtless more pronounced in the portion of the Arctic Circle between the west end of the Parry Isles and Spitzbergen, where the numerous groups of islands cut it up into narrow straits and passages which form so many ducts for its escape to the south. Over the other portion of the Circle which we know less about, and which embraces a far larger extent of sea, it is doubtless less pronounced in a southerly direction, and there is no decided current through Bering Strait one way or the other, which is probably owing to the very shallow water (less than 20 fathoms) for a considerable distance on either side of its entrance; Bering Strait is the only outlet on that side of the Pole.

Now this general southerly outflow which I have mentioned is of a very weak character, considered as a current, and every ship which has ever penetrated north has had to do so against it, and has found no difficulty in doing so while there has been sufficiently open water or loose ice to make steam or sail power available; when this has not been the case, and a ship has not got within the inner waters before the new ice of autumn is formed, she is certain to be carried back by this outflow by slow degrees with the ice, and to reach the open water probably early in the spring. I cannot find any reason for believing that a current sets north over the Pole from the New Siberian Islands which Dr. Nansen hopes for and believes in. Dr. Nansen, I think, calculates it at about 2 miles a day; there is nothing in the *Jeannette* expedition to support such a theory; she made something like 900 miles from Bering Strait in nearly two years, in a direction north of west, or nearly with the line of coast, and was then crushed near the position where Dr. Nansen's current commences.

It is my opinion that when really within what may be called the inner circle, say about 78° of latitude, there is little current of any kind that would influence a ship in the close ice that must be expected; it is when we get outside this circle, round the corners as it were, into the straight wide channels, where the ice is loose, that we are really affected by its influence, and here the ice gets naturally thinner and more decayed in autumn, and less dangerous to a ship. Within the inner circle probably not much of the ice escapes; it becomes older and heavier every year, and in all probability blocks the navigation of ships entirely. This is the kind of ice which was brought to Nares' winter quarters at the head of Smith Sound, in about 82° 30′ north, and this is the ice which Markham struggled against in his sledge journey, and against which no human power could prevail.

I must not omit to allude very briefly to the only tangible evidence which Dr. Nansen brings in support of his currents, viz., the articles said to have been found in Greenland belonging to the *Jeannette*. I don't for a moment impute any bad faith to the authors of this story, nor do I include it among the many fables which have been rife since the Franklin Expedition, most of them made to order as marketable articles, but I attach no real importance to it. If found in Greenland they may well have drifted down on a floe from the neighbourhood of Smith Sound, from some of the American Expeditions which went to Greely's rescue. It may also well be that some of "De Long's" printed or written documents, in regard to his equipment, may have been taken out by these Expeditions, and the same may apply to the other articles. But even if it were possible to accept this evidence it would only mean that a piece of ice with these relics had been coach-wheeled in some way round the polar basin to Greenland in three years, and could not afford a very encouraging hope for Dr. Nansen's ship. I regret to have to speak discouragingly of this project, but I think that any one who can speak with authority, ought to speak plainly

where so much may be at stake. I have always rested my hope of the North Pole or its neighbourhood being reached by sledge journeys along the land ice, north of Smith Sound. The expedition of 1875, however, under Nares dissipated this hope by proving the improbability of any land at a convenient distance in that direction, and if this is so, there remains only the possibility of its accomplishment by ship navigation. I confess that I have never been an advocate of amateur nautical expeditions for such service as this; and for obvious reasons. It must be admitted, however, that they have one advantage; their anxieties are not added to by the knowledge that they become the objects of rescue almost before they are well into the regions of danger.

In Government Expeditions, especially from this country, the excessive caution which it is perhaps necessary to insist on to ensure the certainty of a safe retreat, demands a system of supports which fetters the action of the commander, and by separating his ships during winter, deprives him virtually of half his travelling force in early spring. Such reasons will probably be a bar to any Government Arctic enterprise for many years to come; whatever may be undertaken in the Antarctic region, which is virgin ground, and where the conditions are probably so different, that it may not be necessary to pass a winter, at any rate where a reconnaissance would first be made. The solution of the Polar problem, if it is ever solved, may therefore possibly be effected by some such effort as the present one.

All British Arctic men will, I believe, hope that Dr. Nansen may be the successful explorer, and that he may reap the reward due to his pluck and enterprise. They will certainly welcome him home, successful or unsuccessful, long before the expiration of the almost countless years for which he is prepared to persevere. I think he is very wise to commence his voyage by way of the Kara Sea, instead of by Bering Strait, to reach which and get on the threshold of his labours a voyage of about 20,000 miles must first be accomplished. By adopting Nordenskiold's course he is certain at any rate to add something to our knowledge of these little-known regions.—GEORGE HENRY RICHARDS.

In compliance with your request, I have carefully studied Dr. Nansen's able and clear statement of his reasons for adopting the course he has chosen for reaching the hitherto unexplored Arctic area, and his preparations for its accomplishment.

Dr. Nansen's project is a wide departure from any hitherto put in practice for the purpose of Polar discovery, and it demands the closest scrutiny, both on this account and because it is one involving the greatest peril. The following considerations respecting it have occurred to me.

From my experience of three seasons in the Antarctic regions I do not think that a ship, of whatever build, could long resist destruction if committed to the movements of the pack in the Polar regions. One built as strongly as the *Fram* would no doubt resist great pressures in the open pack, but not any pressure or repeated pressures, and still less the thrust of the pack if driven with or by it against land. The "lines" of the *Fram* might be of service so long as she was on an even keel, or in ice of no great height above the water-line, but amongst floes and bergs, or when thrown on her beam-ends, they would avail her nothing.

The contingency of the *Fram* being, by a divergence of the assumed currents, stranded on the north coast of Greenland, or of the American Polar Islands, or elsewhere, should be taken into account. Assuming that a landing could be effected, it must be on an inhospitable and probably ice-bound coast, or on the mountainous ice of a palæocrystic sea. With a certainly enfeebled, and probably

reduced ship's company, there could, in such a case, be no prospect of reaching succour.

Putting aside the possibility of scurvy (against which there is no certain prophylactic), have the depressing influences on the minds of the crew, resulting from long confinement in very close quarters during many months of darkness, extreme cold, inaction, ennui, constant peril, and the haunting uncertainty as to the future, been sufficiently taken into account? Perfunctory duties and occupations do not avert the effects of these conditions; they hardly mitigate them, and have been known to aggravate them.

I do not consider the attainment of Dr. Nansen's object by the means at his disposal to be impossible; but I do consider that the success of such an enterprise would not justify the exposure of valuable lives for its attainment; and I may conclude with expressing the hope that Dr. Nansen may dispose of his admirable courage, skill, and resources in the prosecution of some less perilous attempts to solve the mystery of the Arctic Area.—Jos. D. Hooker.

EXPLORATION AND CHARACTER OF THE PRINCIPAL NEW ZEALAND GLACIERS.*

By A. P. HARPER, Hon. Sec. New Zealand Alpine Society.

The broad features of the mountain system of the South Island of New Zealand are tolerably well known, and need only be briefly referred to here. Beginning at the north end of the South Island, we find, in Nelson and Marlborough Provinces, numerous ranges spreading from coast to coast, and reaching in many instances to over 8000 feet. They include some grand peaks, on which snow is to be seen during most of the year, while the lower spurs are clothed in luxuriant forest, of which a considerable area has been "cleared" and brought under cultivation. Further south these ranges draw together, till, in the Southern Alps, they form a great mountain wall, running from N.E. to S.W., which sends off a number of spurs rising into bold Alpine peaks, and for upwards of 100 miles presents a snowy barrier, crossed last season for the first time, by a pass lying at the head of the Godley Glacier, in the north-east of the district embraced by the map.

To the eastward the Southern Alps send out great buttresses, terminating suddenly in the broad Canterbury and Mackenzie plains, which form, by their absolute flatness, a striking contrast to the peaks behind; while westward the mountains slope rapidly, and in many cases fall in sheer precipices for some thousands of feet to the coast, leaving about 10 miles of comparatively level country between them and the sea.

To the south, in Otago, we find the chain spreading out again from coast to coast in lower hills, amongst which are flourishing farms and

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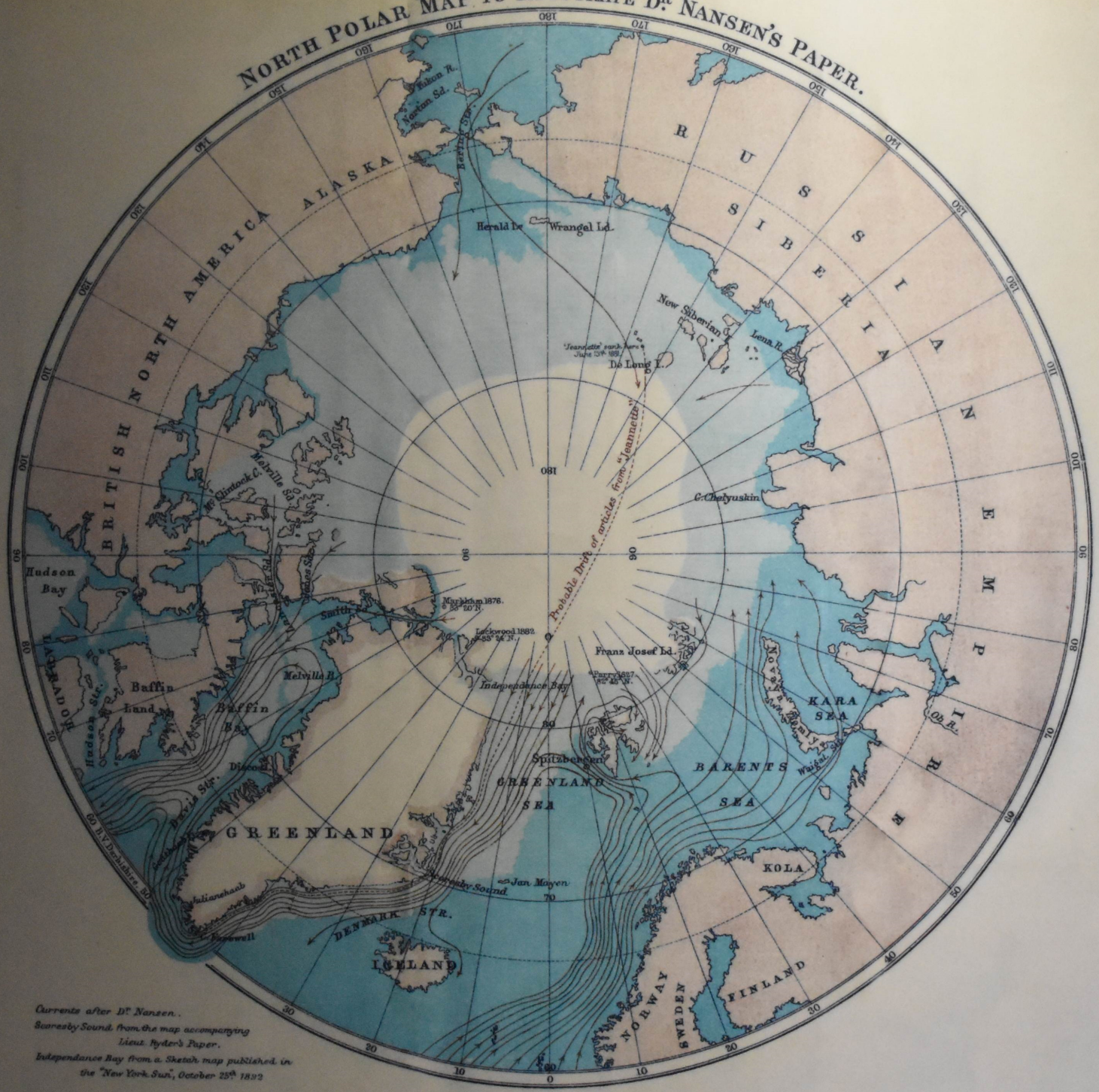
* Map, p. 96.

NORTH POLAR MAP TO ILLUSTRATE Dr. NANSEN'S PAPER.



Currents after Dr. Nansen.
Scoresby Sound, from the map accompanying Lieut. Ryder's Paper.
Independence Bay from a Sketch map published in the "New York Sun", October 25th 1892

Published by the Royal Geographical Society.

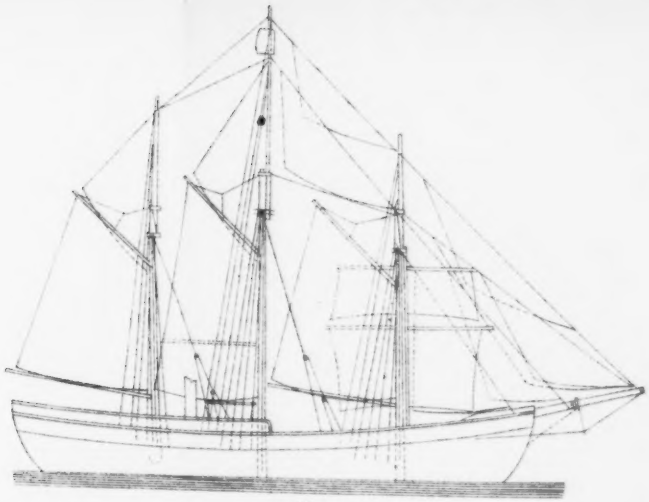


Fig. 1

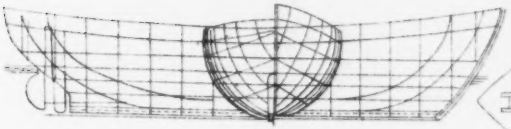
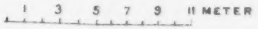


Fig 2



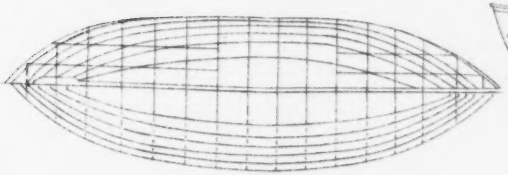


Fig. 3.

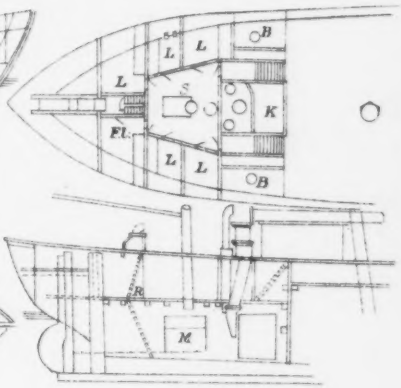


Fig 4.

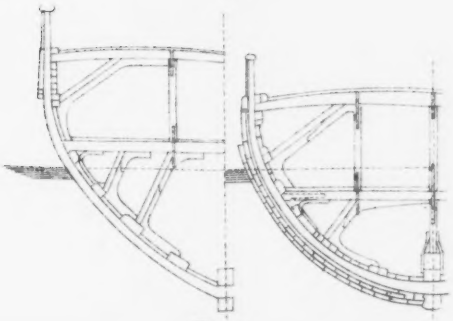


Fig. 5.

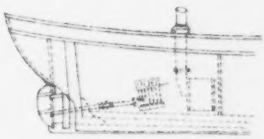


Fig. 6

DIAGRAMS OF DR. NANSEN'S VESSEL, THE "FRAM."

Published by the Royal Geographical Society.